

# Pest Management Grants—Demonstration

## Final Report

Contract # DPR99-0209

Contract Title: Promoting Urban-Based Ecological Pest Management  
(EBPM) : Education and Outreach in East Bay Public  
Schools and Community Gardens (Phase II)

Principal Investigator: Miguel Altieri  
University of California, Berkeley

Contractor: University of California, Berkeley

February 17, 2001

*Prepared for the California Department of Pesticide Regulation.*

The statements and conclusions in this report are those of the contractor and not necessarily those of the California Department of Pesticide Regulation.

The mention of commercial products, their source, or their use in connection with material reported herein is not to be construed as actual or implied endorsement of such products.

### Acknowledgments:

This report was submitted in fulfillment of DPR-9-0209 Promoting Urban-Based Ecological Pest Management (EBPM) : Education and Outreach in East Bay Public Schools and Community Gardens (Phase II) by University of California at Berkeley under the full sponsorship of the California Department of Pesticide Regulation. Work was completed as of October, 2000.

## **TABLE OF CONTENTS**

EXECUTIVE SUMMARY	5.
REPORT	
Introduction	6.
Results & Discussion	6.
Summary and Conclusions	9.
APPENDIX A: TABLES & FIGURES	10.
APPENDIX B: PUBLICATIONS, PHOTOS & FLYERS	18.

## **EXECUTIVE SUMMARY**

The objective of the project was the continuation of phase two of the training, demonstration and outreach project on IPM in urban agriculture at four public schools with school gardens located in low-income neighborhoods of Berkeley and Oakland. Activities included lectures and practical activities in the schools related to agroecology and IPM, including setting up biocontrol experiments in established school gardens and development of ecologically-based pest management (EBPM) lesson plans for teachers. Students provided EBPM outreach to their local community through after-school gardening teams and organized instructional field days. School gardens employed diversified cropping systems that enhanced ecological interactions leading to biological pest suppression and also served as pedagogic tools for integrating ecology, food and agricultural issues into the classroom. Produce from the gardens was used in two school cafeterias and snack programs to enrich children's diets and to make students and their families aware of the nutritional-health importance of locally produced food. Outreach to community groups resulted in the establishment of an additional school garden at Hoover Elementary and a community garden in a low-income neighborhood in Oakland. Such gardens contributed to enhancing local household food security.

During the summer months, 6 students were selected for urban agriculture internships at the University of California's Gill Tract research facility in Albany where they participated in training and participatory research activities on biocontrol and agroecology. Research and demonstration plots established and maintained by the students were featured in a field day open to the community conducted on July 22 in order to expose them to production and crop health impacts of agroecological management such as intercropping, use of flowers as beneficial insect habitats, composting and mulching. The results from the experimental plots were analyzed and showed the following general trends:

- a. Pest damage was higher in chemically fertilized plots compared to organically fertilized ones.
- b. Pest damage was lower in plots that were intercropped with flowering plants such as phacelia and buckwheat.

## **REPORT**

### **A. INTRODUCTION**

The main goal of this project was to establish gardens at various schools in low-income areas featuring vegetable cropping systems producing salad vegetables and some staple crops, and to better integrate in-class science lessons with school gardens. Such activities have served not only to enhance capacity—building on IPM and sustainable agriculture among school children and community members, but produce from gardens have contributed to enrich the nutritional offerings in school cafeterias and to enhance food security in poor households that benefited from outreach efforts. The project was designed so that students could participate in all aspects of garden development, including the use of cultural and biological methods of pest management, and that gardens would serve as a pedagogic mechanism for integrating agriculture, food systems and ecological issues into the classroom curriculum. In addition, demonstration plots at schools and the UC Gill Tract served to promote field days and cross-visits which enhanced outreach of project benefits to other schools and the community at large.

Project objectives:

- a. Integrate existing public school gardens with a science curriculum, incorporating ecologically-based pest management techniques to control insects, diseases and weeds affecting urban gardens.
- b. Build school and community gardens in low-income areas of Oakland featuring EBPM techniques.
- c. Involve students in all practical aspects of garden development and allow students to conduct comparative research in pilot areas of the gardens to test the effects of various agroecological practices on pest incidence.
- d. Disseminate project achievements and results to other schools and the wider community

### **B. RESEARCH RESULTS AND DISCUSSION**

- a. Integrate existing public school gardens with a science curriculum, incorporating ecologically-based pest management techniques to control insects, diseases and weeds affecting urban gardens.

Pedagogic activities have taken place at four public schools in Alameda County: Columbus Elementary, Hoover Elementary, Willard Middle School and MacGregor Extension High School. Additional instruction was provided by M. Altieri and C. Nicholls during spring and fall semesters of year 2000. Student involvement was accomplished both through the curricular activities at the schools and after-school programs. After-school teams met once a week and a group of selected students participated in a summer internship at UC Berkeley's Gill Tract research facility.

- b. Build school and community gardens in low-income areas of Oakland featuring EBPM techniques.

Two gardens were constructed as planned. Garden construction consisted of design, lot clean-up, bed construction, irrigation installation and a meeting kiosk construction. The school garden at

Hoover Elementary was established with student involvement and curricular activities were directly integrated into the school garden.

A community garden was constructed at a location provided by the North Oakland Missionary Baptist Church (NOMBC) with the help of community members and students from Hoover Elementary. Educational activities pertaining to garden pest management were held, along with general gardening instruction.

c. Involve students in all practical aspects of garden development and allow students to conduct comparative research in pilot areas of the gardens to test the effects of various agroecological practices on pest incidence.

In the various schools, groups of students participated in garden development, including garden design, planting, composting, irrigation weeding, etc. as well as in the research dimensions of the project such as identifying and diagnosing pest problems, recognition of beneficial insects, monitoring and sampling pest populations and associated natural enemies, estimating pest damage and yield losses, garden productivity, etc. The collected data were analyzed and discussed during science class.

During the summer months, 6 students were selected for urban agriculture internships at the University of California's Gill Tract research facility in Albany where they participated in training and research activities on biocontrol and agroecology. Students established and maintained research and demonstration plots in order to study the effects of agroecological management such as intercropping, use of flowers as beneficial insect habitats, composting and mulching on plant health and crop productivity.

Over the course of the internship, students were introduced to the principles of urban agricultural production and participated in hands-on experimentation in the field. Students with the help and supervision of the UC Berkeley team set up four experiments to study ecologically-based pest management at the Gill Tract research facility (Figure 1). The main crops, cabbage and broccoli, were planted in 3x3m squares consisting of 16 plants per plot. Each treatment had three replicates that were randomly distributed in a 9x12m area.

The first experiment involved an intercropping system, where students compared a monoculture of cabbage to an intercrop of cabbage with either the purple flower phacelia or buckwheat (Figure 2). Students quantified adult aphid populations through direct counting on plants. The results showed a significant reduction in the aphid populations in the buckwheat intercrop compared to the monoculture, and even a higher reduction in the phacelia intercrop (Figure 3). Even though both flowering intercrops provided significant biological control of aphids, the cabbage yields were found to be lower compared to the control plots. This was caused by increased competition due to the narrow spacing of the rows of the intercrops and cabbage. A better design such as planting one row of a flowering plant for every four rows of cabbage should prevent the competition and shading from buckwheat and phacelia plants while providing pollen and nectar to attract beneficial insects.

In the second experiment, students planted wild mustard at varying densities in 16 square meter plots planted to broccoli. The objective was to assess whether wild mustard acted as a trap crop for aphids and flea beetles, and if the trap cropping effect was related to wild mustard densities. There was a significant difference between aphid numbers on monoculture broccoli plants and those in the mustard treatments on all eight days of sampling (Figure 4) but no significant differences were found among mustard density treatments. Flea beetle populations were

significantly higher in the monoculture compared to the various mustard-broccoli intercrops (Figure 5). Numbers were lowest on broccoli plants within plots that had 10-mustard plants suggesting that at least 10 wild mustard plants per 16 square meters are needed to offer effective trap cropping of flea beetles.

In the third experiment, students set up an experiment to determine the effect of the proximity to a flowering vegetation border on the distribution of natural enemies and their impact on biological control of aphids in adjacent crops. Six rows of cabbage were planted at a distance of one to ten meters from a buckwheat or a phacelia vegetation border. Students monitored the aphid populations through direct counting on cabbage plants. Analysis of the data showed that plants closest to the buckwheat border had the lowest numbers of aphid populations (Figure 6a). Similar results were observed in the plot with the phacelia border (Figure 7a). Aphid populations tended to increase with distance from the border, reaching a plateau at around 5 meters. The percent parasitism of aphids also decreased with increased distance from both the phacelia and buckwheat borders (Figure 6b, 7b). The data from these experiments were not conclusive enough to determine the optimal distance from the border, but showed clearly that close proximity of crops to the flowering border increases pest suppression.

In the final experiment, students amended cabbage plants with either a chemical fertilizer or chicken compost. A single or a double dose was added in such amounts as to provide equivalent amount of Nitrogen per dose. The students monitored aphid populations through the summer and found significantly higher populations of aphids in the plots amended with the chemical fertilizer as compared to the organic amended plots (Figure 8). The largest difference was observed in the plots amended with a single dose of organic fertilizer which had a 55% reduction in aphid population compared to the single dose of chemical fertilizer. One hypothesis that was discussed with the students to explain such differences was that chemically fertilized plants had a higher concentration of free nitrogen in the leaves, thus rendering chemically fertilized plants more attractive to aphids. It is important to note that yields of the cabbage plants in the single dose organic fertilizer plots were also higher than chemically amended plots, making the organic fertilizer a much more desirable choice (Figure 9).

d. Disseminate project achievements and results to other schools and the wider community

Outreach activities such as field days, workshops and cross-visits were conducted in the participating schools through after-school youth gardening teams. Demonstration plots have been established at Willard Middle School, Columbus Elementary School, MacGregor High School, the M.R. Baker YMCA, Hoover Elementary and North Oakland Missionary Baptist Church community garden. Demonstration areas have also been established at the Berkeley Youth Alternative employment garden.

A field day for the general community (co-sponsored by the Bay Area Coalition for Urban Agriculture – BACUA) was held on July 22 at the Gill Tract research facility. Many people from the surrounding communities attended, and the students presented their results and gave tours of experimental plots to participants who had the opportunity to observe directly the various management systems, their effects on key pests and the differences between treatments. In addition, through lectures and demonstrations community members and students learned about biological control, soil management and agroecology. A second field day was held on October 7 at the Gill Tract research facility in coordination with the Open Gardens Day event in the East Bay. Many people from the East Bay who took part in the Open Gardens tour stopped at the Gill Tract and toured the various experimental plots.

Also, on September 23, Altieri and Nicholls gave a whole day course on urban agriculture to 25 people that enrolled in a UC Berkeley Extension course. During the course, research data derived from the Gill Tract experiments were utilized to illustrate agroecological principles.

A paper entitled "Exploring the potential of urban agriculture in the San Francisco Bay Area" which describes some of the activities of the project has been submitted for publication in California Agriculture.

#### SUMMARY AND CONCLUSIONS

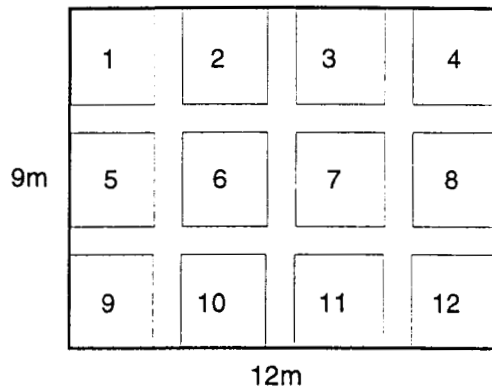
Based on the activities and achievements presented above, it can be stated that our training, demonstration and outreach project on EBPM in urban agriculture has been successful in continuing the capacity building activities in schools and surrounding communities through:

- Implementation of garden activities and training modules at schools
- Integration of garden activities to curricular program
- Conduction and evaluation of comparative research projects by students
- Outreach activities to the rest of the community through field days at Gill Tract and established school gardens

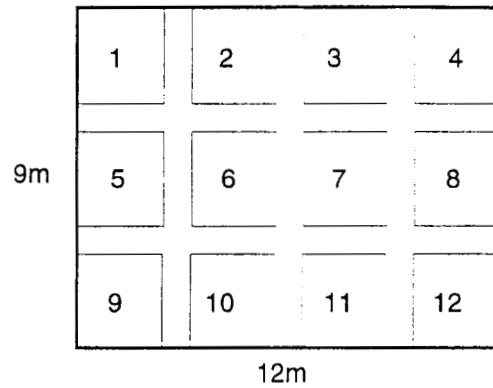
Our project differs from other initiatives in the Bay Area promoting local sustainable agriculture through community gardens, in that it is based on scientific principles of agroecology and EBPM with efforts specifically targeted at public schools to train students in urban agriculture and environmentally sound methods of pest control. Through field days, direct involvement of students through internships in community gardens, etc. benefits are extended to the community. In this way urban gardeners exposed to such outreach efforts are becoming increasingly aware of EBPM principles which in turn we expect will result in a substantial decrease in the use of pesticides in urban agricultural areas, thus leading to overall enhanced environmental quality in our communities.

# EXPERIMENTAL PLOT LAYOUT

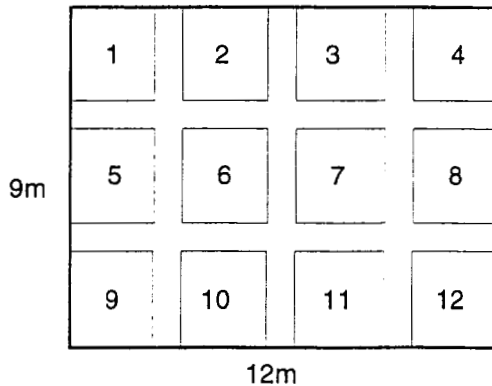
## Mustard Trap Crop Experiment



## Intercropping Experiment



## Organic vs. Chemical Fertilizer Experiment



## Insectary Border Experiment

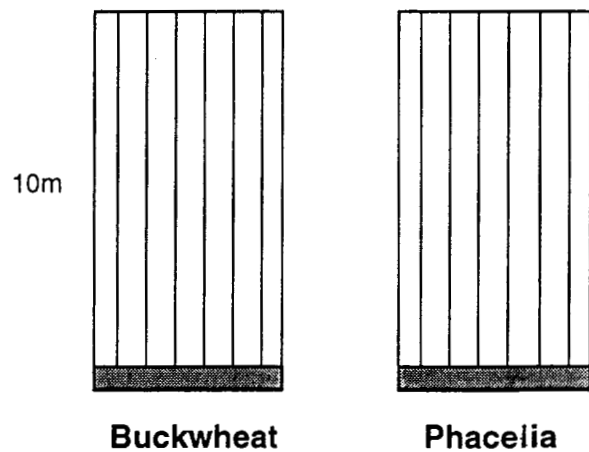


Figure 1. Physical layout of experimental and demonstration area. Each experiment (except border exp.) contains 12 plots of 4x4 grids planted with cabbage or broccoli. The insectary border experiment, consists of two plots each planted with six rows of cabbage plants.



Figure 2. Gill Tract experimental area. Phacelia insectary border (top) and buckwheat insectary border (bottom) planted at the end of two plots of cabbage.

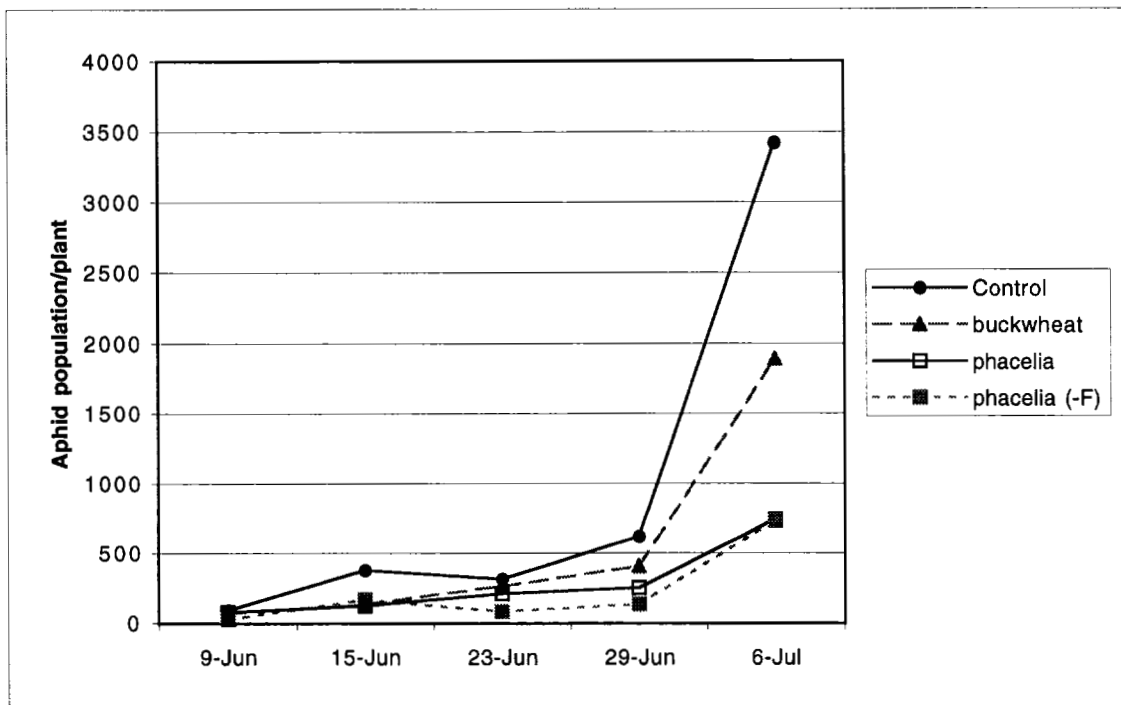


Fig. 3 Aphid populations on cabbage intercropped with phacelia or buckwheat

Figure 4. Aphid populations on broccoli monoculture and broccoli plots with wild mustard used as a trap crop at various densities

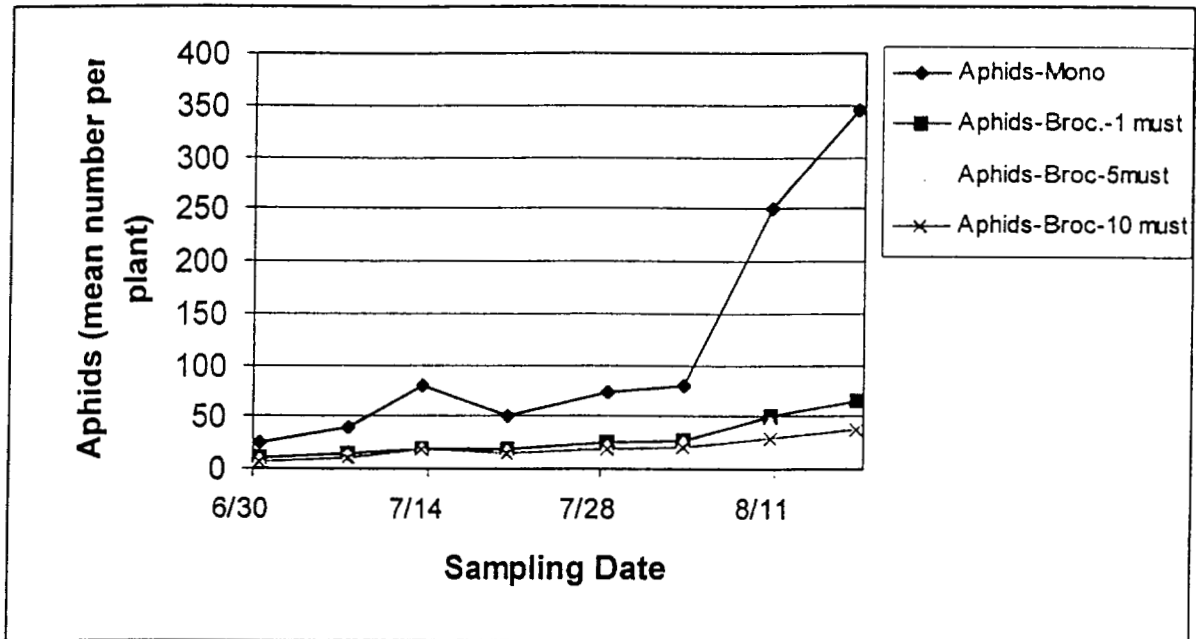
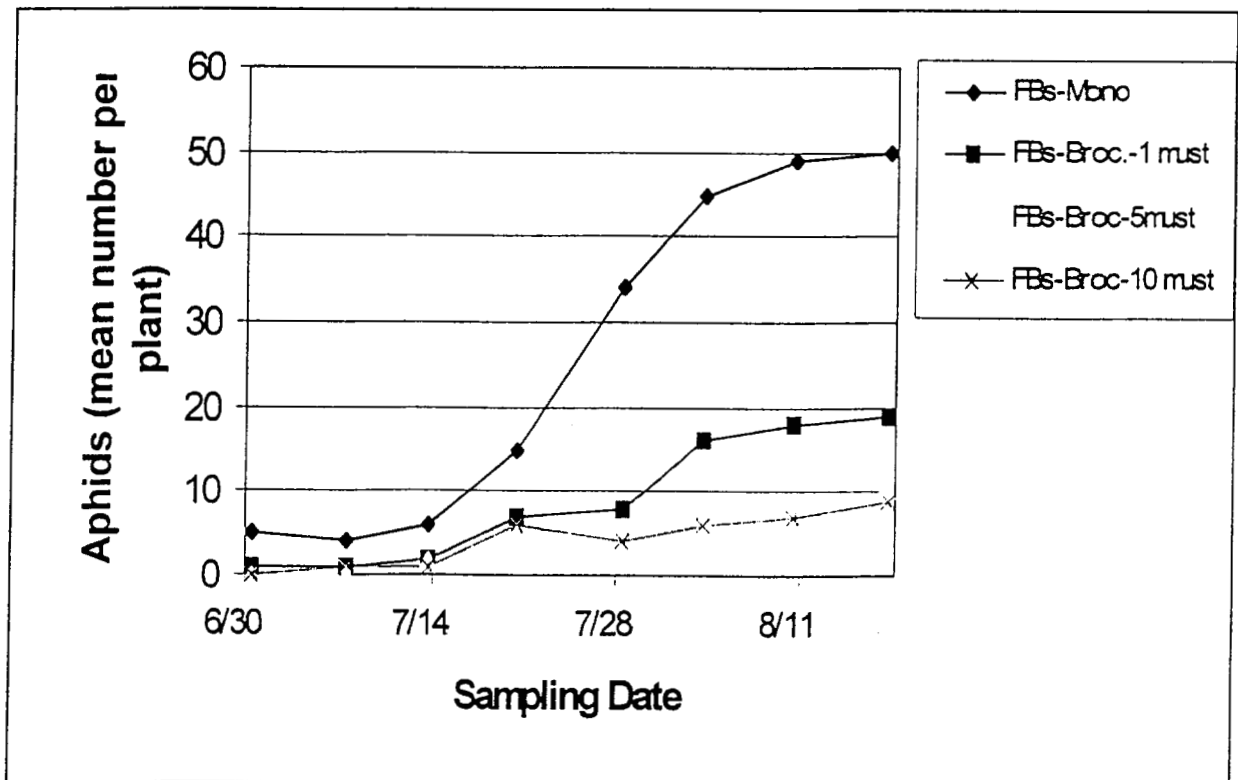


Figure 5. Cumulative flea beetle densities on broccoli monoculture and broccoli plots with wild mustard used as a trap crop at various densities



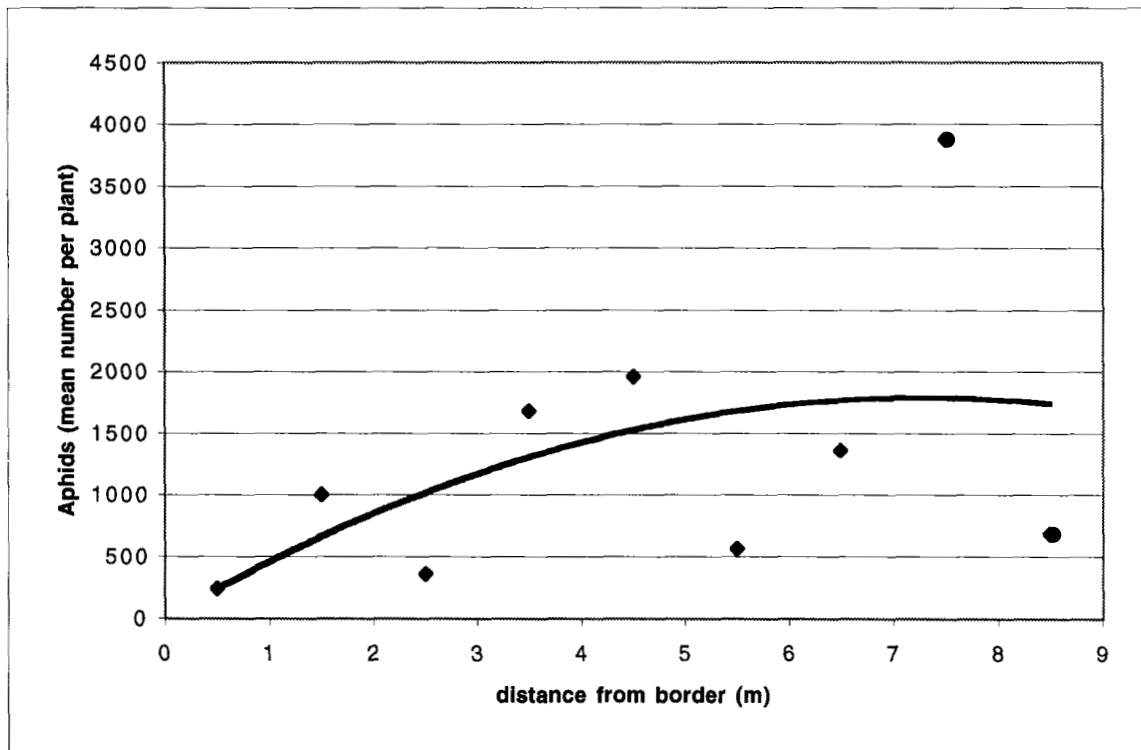


Fig. 6a Aphid populations on cabbage at increasing distance from a buckwheat insectary row

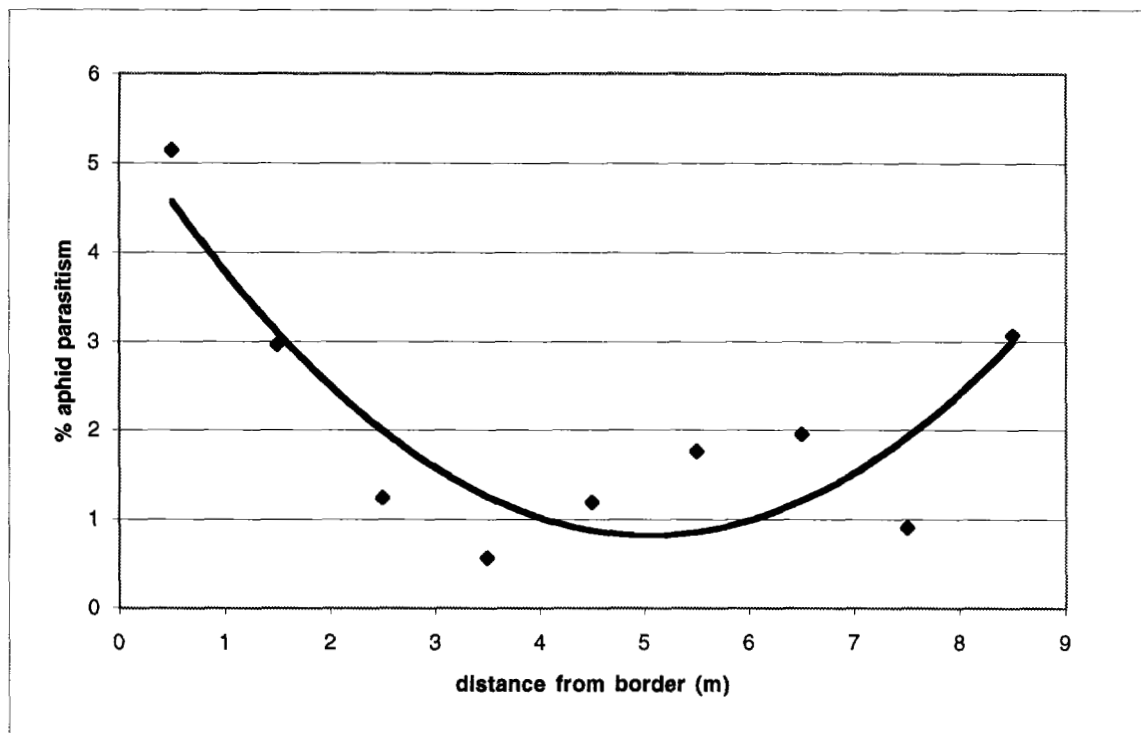


Fig. 6b Percent aphid parasitism on cabbage at increasing distance from a buckwheat insectary row

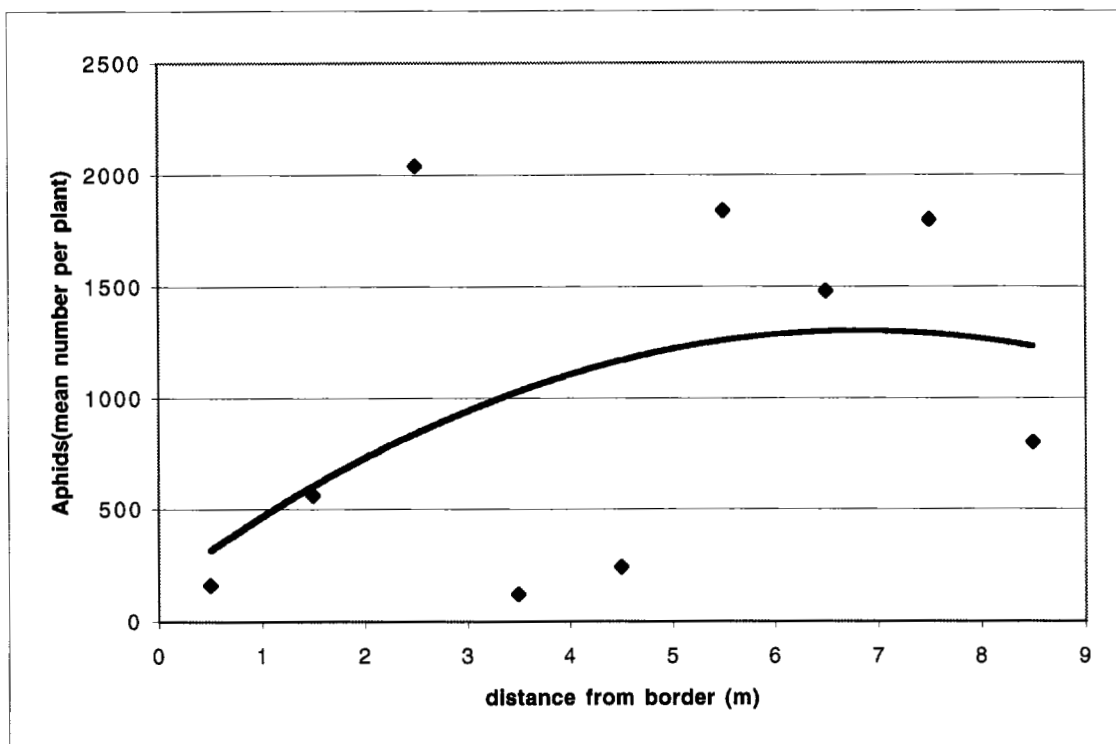


Fig. 7a Aphid populations on cabbage at increasing distance from a phacelia insectary row

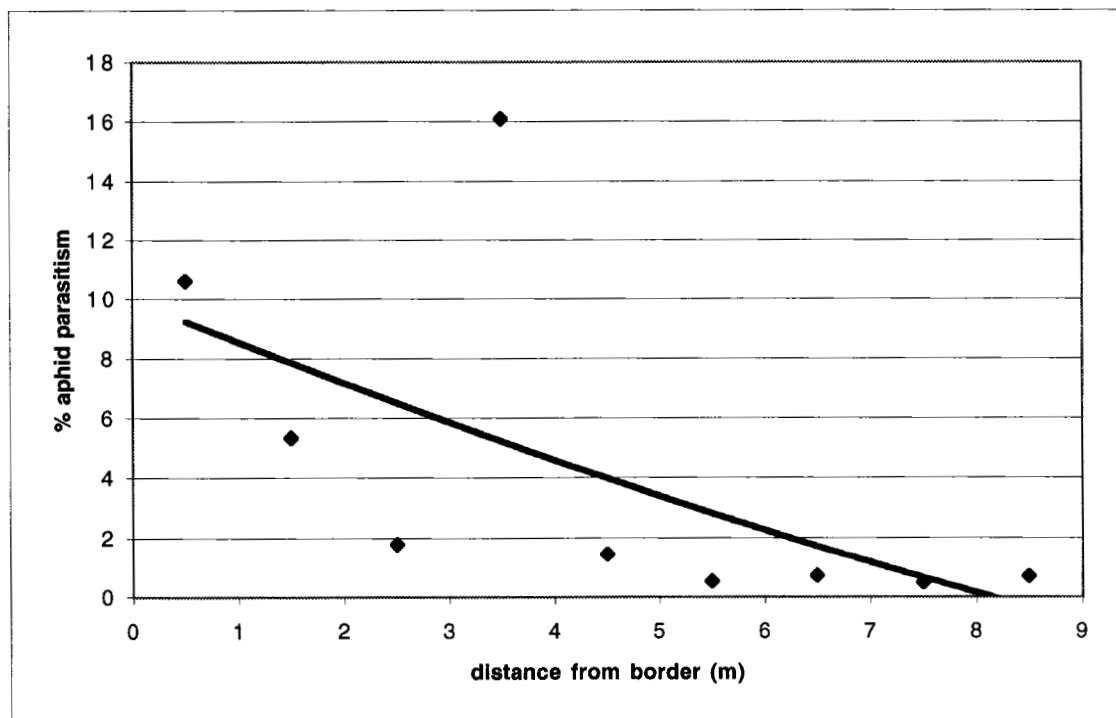


Fig. 7b Percent aphid parasitism on cabbage at increasing distance from a phacelia insectary row

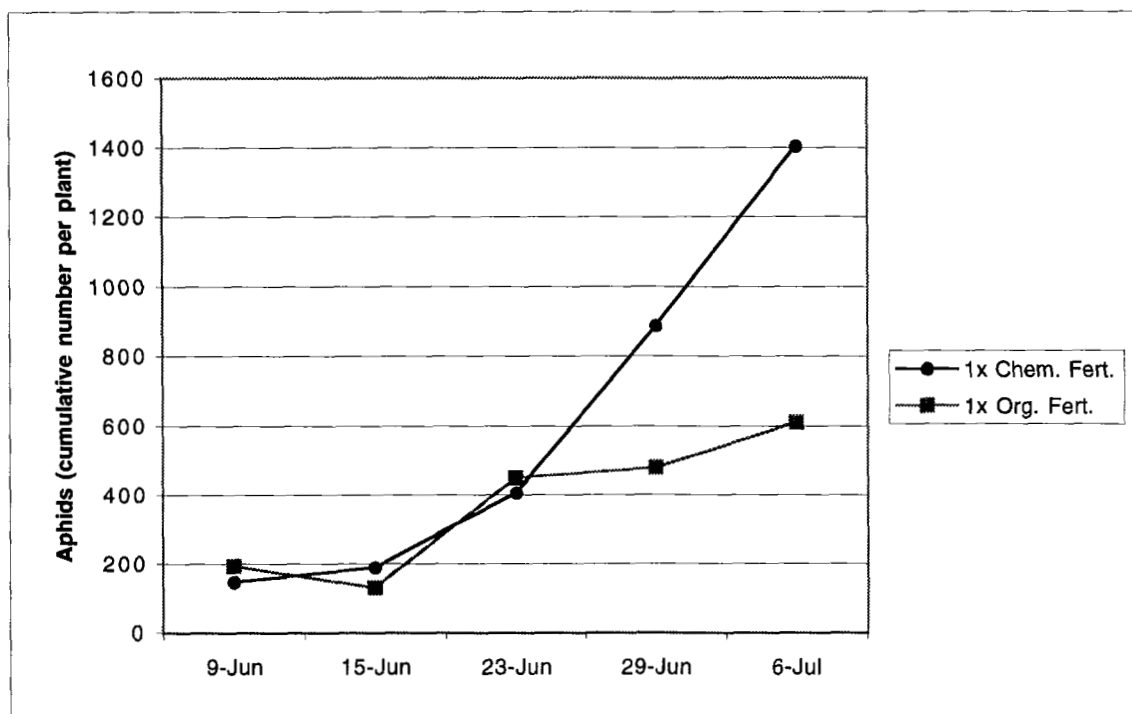


Fig. 8 Aphid populations on cabbage ammended with chemical or organic fertilizer

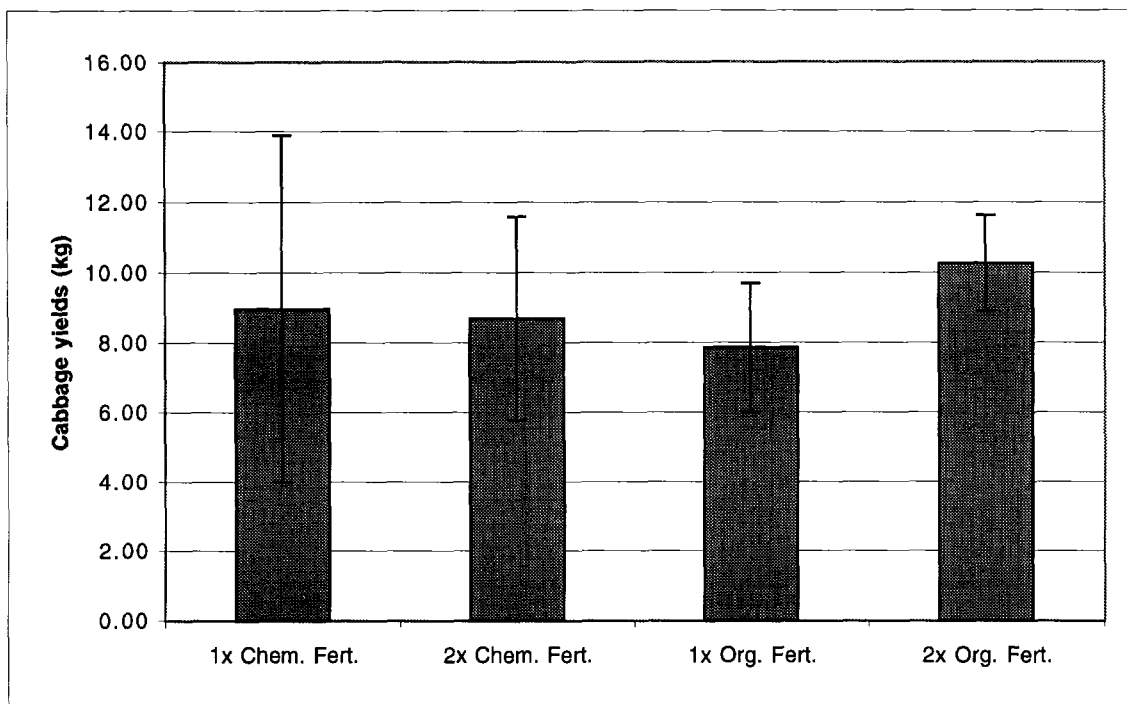


Fig. 9 Cabbage yields from plots ammended with chemical or organic fertilizer



Figure 10a. Gill Tract demonstration area.



Figure 10b. Community Garden construction.